

# **National Water Level Program Support Towards Building A Sustained Ocean Observing System For Climate**

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## **1. PROJECT SUMMARY**

The purpose of this document is to provide a progress report on a continuing program plan for sea level observations that is being implemented by NOAA National Ocean Service (NOS)'s Center for Operational Oceanographic Products and Services (CO-OPS) in support of the NOAA Climate Program Office Global Ocean Observing System for Climate. Two tasks have been identified for which CO-OPS is providing support:

Task 1: upgrade the operation of selected National Water Level Observation Network Stations to ensure continuous operation and connection to geodetic reference frames.

Task 2: operate and maintain water level measurement systems on Platform Harvest in support of calibration of the TOPEX/Poseidon and Jason-1 and Jason-2 satellite altimeter missions.

A third task, to develop and implement a routine annual sea level analysis reporting capability that meets the requirements of the Climate Observation Program, is described in a separate FY2008 Progress Report on Sea Level Change Analysis.

The fundamental URL's are:

<http://tidesandcurrents.noaa.gov> for access to all programs, raw and verified data products, standards and procedures, and data analysis reports and special reports.

<http://opendap.co-ops.nos.noaa.gov/content/> for access to data through an IOOS web portal.

<http://tidesandcurrents.noaa.gov/sltrends/sltrends.shtml> for access to the latest NWLON sea level trends and monthly mean sea level anomalies.

[http://tidesandcurrents.noaa.gov/sltrends/sltrends\\_global.shtml](http://tidesandcurrents.noaa.gov/sltrends/sltrends_global.shtml) for access to the latest sea level trends and monthly mean sea level anomalies for a set of global sea level reference stations.

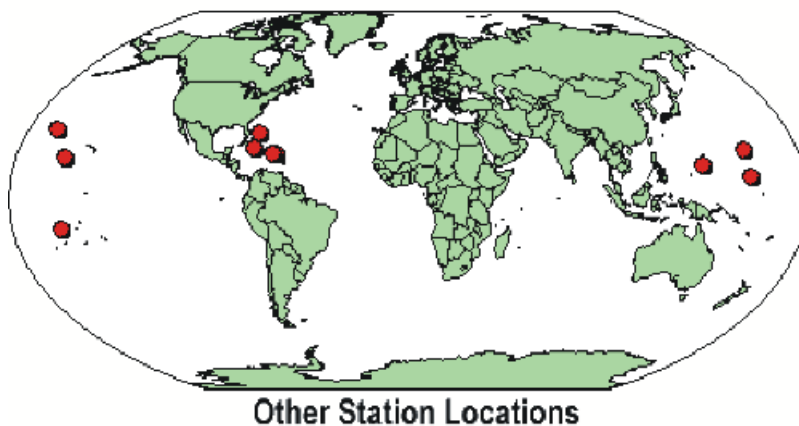
The Climate Operating Monitoring Principles employed by the Climate Program Office are very similar to those used by NOAA's National Water Level Program (NWLP). NWLP's backbone observation system is the National Water Level Observation Network (NWLON) is a long-term continuous operational oceanographic network which meets several of NOAA's mission needs for tides and water levels. The NWLP is an end-to-end program that is planned, managed, and operated to provide products that meet user-driven needs. The program is also comprised of continuous quality control, data base management, operational readiness, continuous

developments in technology, and fully open web-site for data delivery. These data and associated sea level products are made available over the web-site for use by PSMSL, UHSLC, and the WOCE communities. \$125k was provided in last year's (FY2008) budget request to accomplish the two tasks described below.

### 1.1. Tide Station Network

#### *Task 1: Upgrade NWLON Remote Ocean Island Station Operations*

There are several coastal and island NWLON stations critical to the Global Ocean Observing System for Climate. The operation and maintenance of the ocean island and the more remote stations of the National Water Level Observation Network (NWLON) has been increasingly difficult over time due to the slow abandonment of the facilities at which some of the stations reside and the resulting decrease in accessibility. Finding routine and/or cost-effective flights is becoming increasingly difficult; yet these stations require high standards of annual maintenance to ensure the integrity of their long term data sets. Annual maintenance is even more important, in light of the fact that corrective maintenance is logistically very difficult and expensive.



**Figure 1.** Ocean Island NWLON Station Map

Although operation of all of the long-term NWLON and GLOSS stations is important, the NOAA NWLON Ocean Island stations are being upgraded first with Climate Program office funding to ensure their continuous operation (NOS program funding and budget initiatives are used for operation of the coastal stations). These targeted funds are being used for travel costs and for upgrade to the data collection systems. The upgrades include high accuracy acoustic or paroscientific pressure sensors and redundant Data Collection Platforms (DCP's) with equal capability to the existing primary systems. The station operations are also being systematically enhanced with GPS connections to geodetic networks followed by connection to CORS at selected sites. The following is a list of the ocean island NWLON stations (not including Hawaii) that have been considered in this category as priority for upgrade.

**Table 1.**

| Station:             | GPS Connection | Station DCP Upgraded |
|----------------------|----------------|----------------------|
| Guam                 | 2008           | 2007                 |
| Kwajalein            | 2008           | 2007                 |
| Pago Pago            | 2008           | 2006                 |
| Wake                 | 2008           | 2006                 |
| Midway               | sched. 2009    | 2007                 |
| Adak                 | sched. 2009    | sched. 2009-10       |
| Bermuda              | 2008           | 2008                 |
| San Juan, PR         | sched. 2009    | *                    |
| Magueyes Island, PR  | sched. 2009    | *                    |
| Charlotte Amalie, VI | sched. 2009    | *                    |
| St Croix, VI         | sched. 2009    | *                    |

\* DCP's at these stations have recently been upgraded using Base funding by CO-OPS.

#### *Task 2: Satellite Altimeter Mission Support*

Support for the TOPEX/Poseidon satellite altimeter mission began with installation of an acoustic system and a digibub system on Platform Harvest in 1992 (see Figure 2). System operations include provision of water level measurements relative to the satellite altimeter closure analysis reference frame for calibration monitoring (see B. Haines et al, Special Issue of Marine Geodesy, 2003 "The Harvest Experiment: Monitoring Jason-1 and TOPEX-Poseidon from a California Offshore Platform"). This station continues to support the Jason-1 and Jason-2 Altimeter Missions.



**Figure 2.** Platform Harvest Calibration Site at which the NOAA tide station is located.

CO-OPS' special support has included periodic vertical surveys on the Platform necessary to relate the water level sensor reference zeros (near the bottom catwalk) to the GPS reference zero

(located up top at the helipad on the Platform). Continuous data are required to monitor effects of waves on the water level measurements and to ensure provision of data during the times of altimeter overflights every ten days. The original acoustic system was replaced by a digibub (bubbler/pressure) system prior to the Jason-1 altimeter launch.

The two digibub pressure tide gauge systems are collecting continuous water level data streams surveyed into the Platform and Satellite Orbit Reference frames. Funding is used cover travel, routine and emergency maintenance, and water level and ancillary sensor calibrations. Raw and verified 6-minute interval water level data are posted on the CO-OPS web-site.

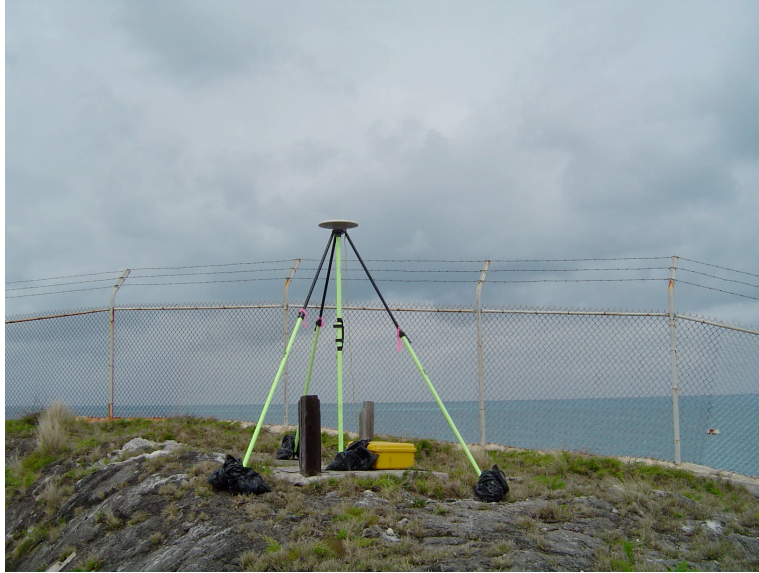
## **2. FY2008 ACCOMPLISHMENTS**

### **2.1. Task 1**

Maintenance and upgrade of the ocean island NWLON stations continued in FY 2008. Redundant system upgrades were installed and GPS surveys conducted at Bermuda last year. The surveys included connections to reference benchmarks for the nearby Continuously Operating Reference System (CORS) (See Figures 3a and 3b).



**Figure 3a.** The tide station on the fuel pier at Bermuda.

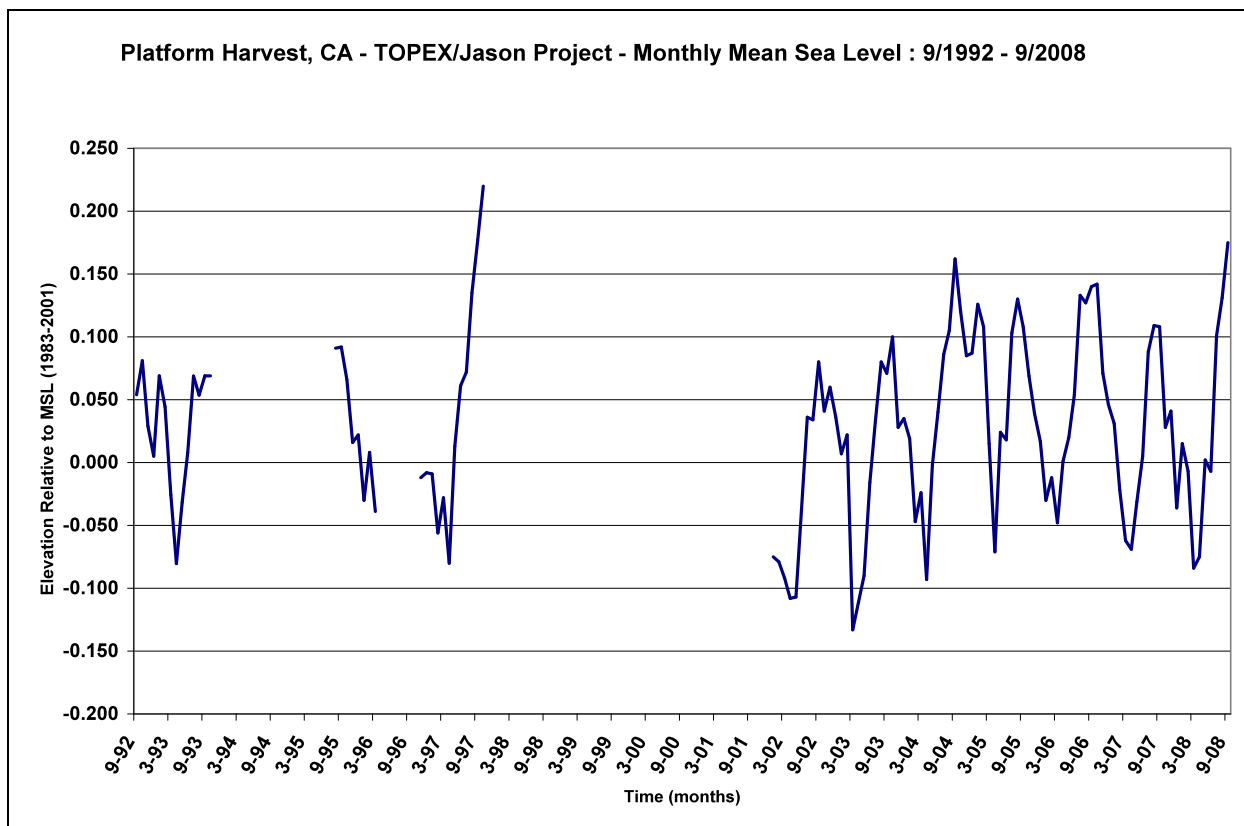


**Figure 3b.** A GPS survey being made on one of the tidal bench marks at Bermuda.

GPS survey connections have now been made at all remote ocean island stations except for Adak Alaska and the U.S. Virgin Islands (to be accomplished FY09). DCP's have been upgraded and redundant systems have been installed where required at all stations in Table 1. FY2008 funds were also used to continue upgrade of the sensors at remote island stations by purchasing high-accuracy parascientific sensors to replace older technology pressure transducers and purchasing memory cards for the DCP's installed last year.

## **2.2. Task 2**

Operation and maintenance of the Platform Harvest station (see Figure 2) continued over the past year. Coordination of activities continues with JPL. Two DCP's are operational and data from both are interchangeably used to obtain a continuous record when on DCP goes down. JPL continues to obtain the data at the time of every 10-day satellite crossover and provides periodic reports on the status of the verification project at Platform Harvest. The tide station has been reporting at intermittent intervals since September 1992, with near-continuous data since 2002 when the Climate Program Office funded a hardware upgrade. Figure 4 shows observed monthly mean sea levels for the period of record. The strong signal due to the annual variation in sea level is evident in the plot. The onset of the 1997 El Niño is also evident just prior to the gap in the data.



**Figure 4.** Platform Harvest Verification Site – Observed Monthly Mean Sea Level from the Tide Station from 9/1992 thru 9/2008.

### 3. PUBLICATIONS AND REPORTS

Results, analyses, and data products are routinely updated and reported on via the CO-OPS web site at: <http://tidesandcurrents.noaa.gov/sltrends/sltrends.html>. Derived sea level trends and related products are reported on in the companion *Progress Report for FY2008 Sea Level Change Analysis* being submitted by CO-OPS along with this progress report on the tide station network.

The original reference for the Platform Harvest operations is *Marine Geodesy, Volume 18, Numbers 1-2*, January-June 1995, Special Issue: TOPEX/POSEIDON Calibration/Validation.

For the most recent results of information from Platform harvest. See “Overview of the Calibration/Validation of OSTM/Jason-2 by Pascal Bonnefond and Bruce Haines at <http://sealevel.jpl.nasa.gov/OSTST2008/agenda.html>.